

Patent Claims

Method for Measuring a Contour of a Workpiece by Scanning

1. Method for capturing and/or measuring capturing a contour of a workpiece by scanning by means of a coordinate measuring device while employing at least one first and at least one second sensor, wherein, by means of the at least one first sensor, first a contour of the workpiece in one plane is scanned, and then the information obtained from the scanning operation is used to determine the travel paths of the at least one second sensor.
2. Method pursuant to claim 1, wherein an image processing sensor is used as at least one sensor.
3. Method pursuant to claim 1, wherein a feeler measuring upon contact is used as at least one sensor.
4. Method pursuant to claim 1, wherein a touchless distance sensor is used as at least one sensor.
5. Method pursuant to claim 1, wherein a fiber-optic feeler is used as at least one of the sensors.
6. Method pursuant to at least one of the above claims, wherein at least one of the sensors is used to position at least one other sensor within its working area.
7. Method pursuant to at least one of the above claims, wherein at least one of the sensors is used to avoid a collision of further participating sensors.
8. Method pursuant to at least one of the above claims, wherein different illumination arrangements, such as incident light or transmitted light, are used for at least one image processing sensor.

9. Method pursuant to at least one of the above claims, wherein, when using an opto-tactile feeler with a feeler element, the scanning direction required for the feeler element correction is generated from the information of a further sensor.
10. Method pursuant to at least one of the above claims, wherein the scanning direction of one or the contact feeler required for the feeler element is generated from information of another sensor.
11. Method pursuant to at least one of the above claims, wherein at least one image processing sensor is focused on the basis of a measuring reading determined with a distance sensor.
12. Method pursuant to at least one of the above claims, wherein at least one image processing sensor is focused on the basis of a measuring reading determined with a contact feeler.
13. Method pursuant to at least one of the above claims, wherein a scanning operation occurs within one step, and wherein processing of the sensor information is performed on-line.
14. Method pursuant to at least one of the above claims, wherein the scanning operation occurs in several individual steps, and wherein processing of the sensor information does not occur in line with scanning.
15. Method pursuant to at least one of the above claims, wherein the third coordinate to the contour scanned in the plane or a contour offset thereto is captured using a second sensor.
16. Method pursuant to at least one of the above claims, wherein a scanning plane is defined a priori and a distance sensor is displaced in the plane such that the distance value is a constant, wherein the method is not performed in the direction of the axis of the sensor.
17. Method pursuant to at least one of the above claims, wherein the scanning operation or operations are performed on one or more coordinate measuring devices.

18. Method pursuant to at least one of the above claims, wherein at least one of the sensors is an image processing sensor, in which the magnification is modified.
19. Method pursuant to at least one of the above claims, wherein a combination of sensors is used, such as image processing with laser distance sensor and/or image processing with contact feeler and/or image processing with fiber feeler and/or opto-tactile feeler and/or image processing with image processing in various resolutions and/or image processing with various views and/or laser with contact feeler and/or laser with fiber feeler such as opto-tactile feeler and/or contact feeler with fiber feeler such as opto-tactile feeler and/or contact feeler with contact feeler with various feeler elements or sensitivity levels and/or fiber feeler with fiber feeler with various feeler elements or sensitivity levels is used.
20. Method pursuant to preferably at least one of the above claims, wherein the contour is measured in an opto-tactile manner by means of a feeler that is moved along said contour and an optical sensor assigned thereto and that the movement of the feeler along the contour is controlled by means of an image processing sensor.
21. Method pursuant to claim 20, wherein both the measuring readings of an opto-tactile feeler and those of an image processing sensor are used to measure the workpiece contour by scanning.
22. Method pursuant to at least one of the above claims, wherein the measuring operation is performed on a coordinate measuring device.
23. Method pursuant to at least one of the above claims, wherein the regulation of the scanning operation of the coordinate measuring device is implemented via the image processing sensor and the capturing of the measuring points via an opto-tactile feeler.

24. Method pursuant to at least one of the above claims, wherein the same image processing optics and/or camera and/or electronics are used for tracing the contour with the image processing sensor and for measuring the measuring points with the opto-tactile feeler.
25. Method pursuant to at least one of the above claims, wherein a separate optical beam path is used for tracing the contour with the image processing sensor.
26. Method pursuant to at least one of the above claims, wherein the image processing sensor and opto-tactile feeler are integrated such in an optical path that for both sensors adjusted different magnification levels are achieved.
27. Method pursuant to at least one of the above claims, wherein tracing of the contour with the image processing sensor occurs in transmitted light or incident light, wherein simultaneously the measurement with the opto-tactile sensor is performed alternatively in transmitted light or incident light.
28. Method pursuant to at least one of the above claims, wherein a scanning direction of the opto-tactile feeler required for a feeler sphere correction is generated from the image processing contour tracing.
29. Method pursuant to at least one of the above claims, wherein the image processing windows used for contour tracing overlap.
30. Method pursuant to at least one of the above claims, wherein contour tracing is performed using an image processing scanner and, at a previously defined distance to the contour traced in this way, the height of the measurement object is captured using another distance sensor.
31. Method pursuant to at least one of the above claims, wherein the image processing sensors are focused on the basis of a measuring reading determined with a distance sensor.
32. Method pursuant to at least one of the above claims, wherein a laser distance sensor is used as the distance sensor.

33. Method pursuant to at least one of the above claims, wherein the laser distance sensor is integrated in the optical beam path of the image processing sensor.
34. Method for scanning workpiece contours, wherein for the purpose of scanning the contour, a distance sensor is used, a scanning plane is defined in advance in workpiece coordinates, and the distance sensor travels in said plane such that the distance value is a constant, wherein the movement of the distance sensor does not occur in the direction of the axis of the sensor.

Amended Sheet

Description

Method for Capturing and/or Measuring a Contour of a Workpiece by Scanning

The invention relates to a method for capturing and/or measuring a contour of a workpiece by scanning by means of a coordinate measuring device while employing at least one first and at least one second sensor.

Capturing contours for the purpose of measuring workpiece geometries is a typical function of coordinate measuring devices. It is based on the problem that contours of workpieces are supposed to be compared to target contours and/or be used for controlling machine tools to duplicate parts. It is likewise required for comparing master parts to additionally manufactured parts. Currently, methods are used employing so-called measuring feeler systems in which a feeler passes over the searched workpiece contour continuously or gradually, and in this way measuring points are captured. The disadvantage of the method is that filigree contours can be scanned only to a limited extent due to the relatively large size of the feeler elements that is required. We, furthermore, know of methods in which contours are scanned using a light transmission or incident light method by means of optoelectronic image processing. The disadvantage of these methods is that only the respectively upper edges of contours can be measured, not, however, for example, the contour in the center of the flank of an object such as a gear wheel.

For the purpose of measuring filigree 3D objects, tactile optical feelers are known, as those disclosed in EP 0 988 505. Based on the working principle, extremely small feeler configurations can be implemented in this way. The use of such feelers for scanning methods is not

always possible in an optimal fashion due to the flexible behavior of the feeler pins. Controlling the process of tracing the part contour, which is required for scanning, is difficult to implement due to the erratic measuring results of the micro-feelers (e.g., due to stick-slip effects).

From the special publication "Kontrolle (Control) 5/94", Werth Messtechnik GmbH, Gießen, we know of a photo-electronic contour scanning method, in which a CCD camera is used, allowing several thousand measuring points to be recorded per scanning process.

From WO 03/008905 A1 we know of a coordinate measuring device, in which by means of an optical sensor the movement of a tactile optical fiber feeler is determined.

In order to determine the volume of cuboid objects, according to US-B-6,442,530 first and second sensors are used. The length of the objects is determined by means of the first sensors, and their distance to the surface of the object by means of the second sensors.

In order to measure, for example, precision bevel wheels, according to US-A-5,297,055 a multi-function measuring system is proposed, comprising a touchless and a tactile sensor, which are arranged in stationary relation to each other.

A method of the above-mentioned kind is revealed in US-A-4,695,220. According to this familiar method, structures such as circuit paths on a wafer are scanned. Here by means of a first sensor, the entire wafer surface in one plane is recorded. If defects are found using a first sensor, the wafer is aligned with a second sensor, which measures in the area of the defects using greater magnification, while taking the coordinates determined by the first sensor into consideration.

The present invention is based on the problem of further developing a method of the above-mentioned kind, such that the contour of an object, in particular also in the flank area, can be measured with a high level of precision and speed.

The problem is resolved essentially through a method for capturing and/or measuring a contour of a workpiece by scanning by means of a coordinate measuring device while using at least one first sensor and at least one second sensor, wherein, by means of the at least one first sensor, first a contour of the workpiece in one plane is scanned, and the information obtained from the scanning operation is used to determine the travel paths of the at least one second sensor. Here an image processing sensor can be used as at least one sensor. It is also possible to use a contact feeler as at least one sensor. Pursuant to another suggestion, it is provided that a touchless distance sensor is used as at least one sensor. A fiber-optic feeler can also be one of the sensors in question.